

THE ENERGY OBSERVER

Energy Efficiency Information for the
Facility Manager

Quarterly Issue – March 2008

Cool Roofs and Insulation

The Energy Observer

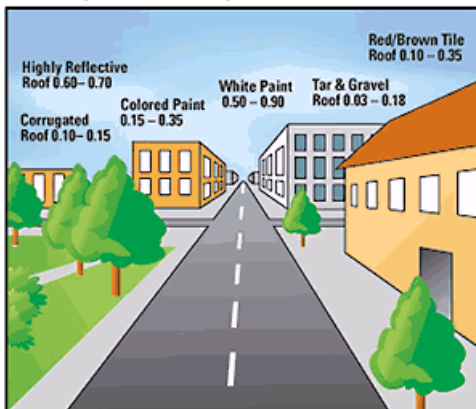
summarizes published material on proven energy technologies and practices, and encourages users to share experiences with generic energy products and services. This quarterly bulletin also identifies informational sources and energy training for facility managers and staff. **The Energy Observer** is a service of the **Energy Office, Michigan Department of Labor & Economic Growth.**

This issue of The Energy Observer focuses on roof modifications to help achieve optimal thermal performance of a building, specifically insulation and turning the roof into a *cool roof*. Insulation is an important factor in achieving thermal comfort for a building's occupants, since its primary function is to mitigate heat flow into and out of buildings. During hot weather, it helps keep the building cool, and in the winter, it keeps heat from escaping. A cool roof can help keep heat absorption of a building to a minimum.

Cool Roofs

There is a lot of potential for energy savings by installing what is known as a cool roof. Over 90% of the roofs in the United States are dark-colored. The low reflectance (or albedo) causes the surface to reach anywhere between 150° to 190°F. In contrast, cool roof systems with low emittance stay up to 70°F cooler during peak summer

conditions. Most cool roof applications have a smooth, bright white surface that allows them to reflect solar radiation, reduce heat transfer to the interior, and save on summertime air conditioning costs. In most U.S. climates, these savings greatly offset any increased heating ("winter penalty") that may occur during sunny winter days.



Various roof albedos (solar reflectance) Source: EPA.gov

Of course, making your roof "cool" isn't your only option for turning your roof into a building energy saver. Adding insulation can be very helpful as well. What follows is an overview of the concept of the R-value and then brief summaries of different flat and low-slope roof insulation types to help make the process of researching and deciding what is best for your facility easier.

R-Value

The R-value of insulation is a measure of its resistance to heat flow. The higher the R-value, the greater the insulating properties.

R-value is determined by an

insulation's material makeup, thickness, and density. R values of multilayered installation can be calculated by adding together the values of the individual layers. Obviously, the more layers of insulation, the greater the R-value and insulating effect. However, the overall R-value of a wall or ceiling is typically different than that of the insulation itself, since heat can flow through the studs and joists.

The amount of insulation and R-value required depends on the climate, type of HVAC system used at the facility, and the part of the building being insulated. For the purposes of this article, we shall only consider insulation used on rooftops.

Types of Roof Insulation

Wood fiber is an organic insulation board made of wood, cane, or vegetable fibers mixed with fillers and binders. The insulation, available only in flat boards, may be either asphalt impregnated or asphalt coated to enhance its resistance to water and moisture. Uncoated insulation should only be used where the roof covering is incompatible with asphalt-based coatings.

Perlite is a type of naturally occurring siliceous rock. What makes perlite unique from other volcanic glasses is that when heated quickly to greater than 1600°F, it expands four to twenty times its original volume. This

expansion creates a material that can be used in many applications due to its exceptional physical properties. When perlite is used as an aggregate in concrete, a lightweight, fire resistant, insulating concrete is produced that is ideal for roof decks.

Polyisocyanurate is a thermosetting type of plastic, closed-cell foam that contains gas, most of the time hydrochlorofluorocarbons (HCFC) in its cells. The high thermal resistance of the gas gives polyisocyanurate materials an R-value of around R-7 to R-8 per inch. However, over time the R-value of the insulation can drop as some of the low conductivity gas escapes and air replaces it. Despite this, its insulating efficiency still remains the highest (see table in the next column).

Polystyrene insulations are manufactured in two ways: as expanded (EPS) and extruded (XPS). EPS is composed of small plastic beads that are fused together. XPS starts as a molten material and is eventually pressed out of a form into sheets.

Cellular glass insulation is made from combining crushed glass with a foaming agent.

Insulation	R-Value/inch
Wood Fiber	2.78
Perlite	2.78
Polyisocyanurate	6.00-8.00
Expanded polystyrene*	3.8
Extruded polystyrene	5
Cellular glass	4.69**
Gypsum board	0.56***
Composite	Varies
SPF	6.85-7.00

*Based on 1.25 pcf density

**Based on minimum 1.5-inch thickness

***Based on 0.5-inch thickness

Source: BENCHMARK and Spray Foam Michigan

The components are mixed, placed in a mold, and heated until the glass melts and the foaming agent decomposes. The mixture expands within the mold to create uniform, connected closed cells to form a rigid insulating material.

Gypsum board is a nonstructural, noncombustible, water-resistant, treated gypsum core panel that may be manufactured with or without glass mat facers. The board is available with a proprietary, non-asphaltic coating on one side to increase adhesion to the roof membrane. Gypsum board is generally used as a cover board over foam plastic insulations, as a thermal barrier over a steel deck, or as a vapor retarder substrate.

Composite insulation boards consist of multiple layers of insulation that are factory

laminated together for specialty purposes. An example of a composite insulation would be expanded polystyrene/wood fiber.

Sprayed Polyurethane Foam (SPF) is applied as a liquid using spray equipment to fill cracks and crevices. It then expands nearly 30 times its original liquid volume and dries to form a hard, closed-cell monolithic roof surface. The density of SPF is important when considering strength and thermal resistance. Most SPF roofs have densities ranging from about 2.5 pounds per cubic foot to 3 pounds per cubic foot. 3 pound density foam has a R-value of around 7.00 installed to 6.80 after time.

More information about roofs can be found at these websites:

http://www.energystar.gov/index.cfm?c=roof_prods.pr_roof_products

<http://www.eere.energy.gov/buildings/info/components/envelope/roofing.html>

<http://www.buildings.com/articles/detail.aspx?contentID=5646>

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